

Docket No. YOR920000644US1
Application No. 10/042,181

REMARKS

Applicant concurrently files herewith a Petition (and fee) for a One-Month Extension of Time.

Claims 1-14 and 24-39 are all the claims presently pending in the application. Non-elected claims 15-23 have been canceled. New claims 31-39 have been added to more completely define the invention.

Claims 24-30 stand rejected upon informalities (e.g., 35 U.S.C. §101 and §112, second paragraph) and claims 1-14 stand rejected on prior art grounds. While Applicant submits that the claims as originally filed clearly would allow one of ordinary skill in the art to know the metes and bounds of the invention, to speed prosecution, claims 24-30 have been amended in a manner believed fully responsive to all points raised by the Examiner, thereby to overcome the §112 and §101 rejections. Incidentally, it is noted for the Examiner that claims 24-30 recite a memory structure, not a process or method.

With respect to the prior art rejections, claims 1-14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kaushik et al. (U.S. PG Publication No. 2002/0137317).

This rejection is respectfully traversed in view of the following discussion.

Attached hereto is a marked-up version of the changes made to the claims by the present Amendment. The attached page(s) is captioned “**Version with Markings to Show Changes Made**”.

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It is noted that the claim amendments herein are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims, or for any statutory requirements of patentability.

Further, it is noted that, notwithstanding any claim amendments made herein, Applicant's intent is to encompass equivalents of all claim elements, even if amended herein or later during prosecution.

I. THE CLAIMED INVENTION

Applicant's invention, as disclosed and claimed, is directed to a data storage element which includes a substrate comprising a semiconductor material, a metal oxide layer including an electrically insulating rare earth metal oxide disposed upon a surface of the substrate, a conductive material disposed upon the metal oxide layer, a first electrode electrically connected to the conductive material, and a second electrode connected to the substrate, to form the data storage element.

With the above unique and unobvious combination of features of the invention, a non-volatile memory is provided where the charging voltage requirements are low ($<7V$), charge retention times are long, and the processing technology is compatible with standard CMOS processing such as aluminum metallurgy.

As a result, when a voltage is applied between the electrodes, beyond a threshold voltage, charge is accumulated in the film, giving rise to a shift in the current voltage and capacitance

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voltage characteristics. Upon reversal of this voltage, beyond a certain threshold, the charge in the film is discharged, thereby leading to the original I-V and C-V requirements being restored.

Independent claims 10 and 24 recite other patentable aspects of the invention.

Such features are not taught or suggested by any of the cited references, including Kaushik et al.

II. THE PRIOR ART REJECTION

A. The Kaushik et al. Reference

Kaushik et al. discloses a high K dielectric film. The Examiner asserts, on page 3 of the Office Action, that “Kausik (sic) et al. disclose a gate dielectric with a substrate comprising of (sic) a semiconductor (12), a metal oxide layer comprising an electrically insulating rare earth metal oxide layer (16) and the conductive material acting as an electrode.”

However, Kausik et al. is far different from the claimed invention. Indeed, even if Kausik et al. discloses grown structures which are somewhat similar, Kaushik's patent is directed to a field effect transistor (FET) design. Indeed, the Examiner clearly recognizes such a fact and such a different aim, as evidenced by his comments on page 3 of the Office Action.

In contrast, the claimed invention is directed to a memory element (e.g., data storage element). These are entirely different devices from the transistor of Kaushik et al., each operating differently, each having different goals, and each being wired differently, as clearly recognized by one of ordinary skill in the art. Thus, one of ordinary skill in the art would not have been motivated to modify Kaushik et al. in the manner urged.

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As a result, there is no relevance of Kaushik's patent to the claims of the present application.

Moreover, technically, in Kaushik's patent, charge placed on top of the oxide layer results in an image charge in the silicon below the oxide, which in turn results in an inversion in the silicon and resultant current transport. The oxide layer thus acts simply as an insulator that separates the charge applied at the top electrode gate and the inversion charge in the silicon, and is therefore a passive modulator.

In the claimed data storage/memory element, on the other hand, the oxide layer acts as an active element that changes internally as a function of the applied voltage, which in turn results in the C-V profile hysteresis that is observed. Thus, the oxide layer of the invention is completely different from the oxide layer shown in Kaushik and indeed the two layer are completely different.

Thus, in Kaushik et al., there is absolutely no teaching or suggestion of “[a] data storage element, comprising: . . . a metal oxide layer comprising an electrically insulating rare earth metal oxide disposed upon a surface of said substrate; . . . , to form said data storage element” (emphasis Applicant’s). Thus, Kaushik et al. is unable to achieve the above-mentioned advantages of the invention, including low charging voltage requirements (<7V), long charge retention times, and processing technology which is compatible with standard CMOS processing such as aluminum metallurgy. .

Hence, independent claim 1 which recites the metal oxide layer, etc. in the claimed combination is patentable over Kaushik et al.

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In view of all of the foregoing, and turning to the clear language of the claims, there is no teaching or suggestion of, for example, independent claim 1 which recites “[a] data storage element, comprising:

a substrate comprising a semiconductor material;

a metal oxide layer comprising an electrically insulating rare earth metal oxide disposed upon a surface of said substrate;

a conductive material disposed upon said metal oxide layer;

a first electrode electrically connected to said conductive material; and

a second electrode connected to said substrate, to form said data storage element”

(emphasis Applicant’s).

Further, independent claims 10 and 24 are patentable for similar reasons.

For the reasons stated above, the claimed invention is fully patentable over the cited references.

Further, the other prior art of record has been reviewed, but it too even in combination with Kaushik et al., fails to teach or suggest the claimed invention.

III. FORMAL MATTERS AND CONCLUSION

The title has been amended pursuant to the Examiner’s helpful suggestions.

In view of the foregoing, Applicant submits that claims 1-14 and 24-39, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in

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condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

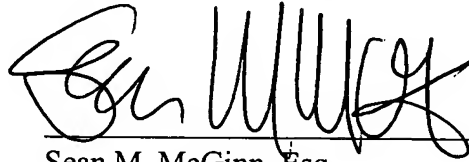
Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Assignee's Deposit Account No. 50-0510.

Respectfully Submitted,

Date:

3/17/03

A handwritten signature in black ink, appearing to read 'Sean M. McGinn', written over a horizontal line.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE TITLE:

Please amend the title as follows:

RARE EARTH METAL OXIDE MEMORY ELEMENT BASED ON CHARGE STORAGE
[AND METHOD FOR MANUFACTURING SAME] (as amended)

IN THE CLAIMS:

Please cancel claims 15-23 without prejudice or disclaimer.

1. (Amended) A data storage element, comprising:

a substrate comprising a semiconductor material;

a metal oxide layer comprising an electrically insulating rare earth metal oxide disposed upon a surface of said substrate;

a conductive material disposed upon said metal oxide layer;

a first electrode electrically connected to said conductive material; and

a second electrode connected to said substrate, to form said data storage element.

10. (Amended) A data storage element, comprising:

a substrate comprising a semiconductor material having a source region and a drain region formed in a surface of said substrate;

a layer of metal oxide disposed upon said surface of said substrate and between said source region and said drain region, said metal oxide comprising at least one metal which has a plurality of oxidation states;

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- a conductive layer disposed upon said layer of metal oxide;
- a first electrode electrically connected to said conductive layer;
- a second electrode connected to said source region; and
- a third electrode connected to said drain region, to form said data storage element.

24. (Amended) A memory, comprising:

- a rare-earth based memory element for storing data based on [using] hysteresis and current-voltage characteristics thereof [to store data].

Please add the following new claims:

--31. The data storage element of claim 1, wherein the metal oxide layer comprises an active element that changes internally as a function of an applied voltage.

32. The data storage element of claim 31, wherein said applied voltage to said active element results in a predetermined current-voltage profile.

33. The data storage element of claim 1, wherein when a voltage is applied between the first and second electrodes, beyond a threshold voltage, charge is accumulated in the metal oxide layer, thereby shifting current-voltage and capacitance-voltage characteristics, and

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wherein upon reversal of the applied voltage, beyond a second threshold voltage, the charge in the metal oxide layer is discharged, thereby restoring original current-voltage and capacitance-voltage requirements.

34. The data storage element of claim 10, wherein the metal oxide layer comprises an active element that changes internally as a function of an applied voltage.

35. The data storage element of claim 34, wherein said applied voltage to said active element results in a predetermined current-voltage profile.

36. The data storage element of claim 10, wherein when a voltage is applied between the first and second electrodes, beyond a threshold voltage, charge is accumulated in the metal oxide layer, thereby shifting current-voltage and capacitance-voltage characteristics, and

wherein upon reversal of the applied voltage, beyond a second threshold voltage, the charge in the metal oxide layer is discharged, thereby restoring original current-voltage and capacitance-voltage requirements.

37. The memory of claim 24, wherein said memory element comprises a metal oxide layer on a substrate,

wherein the metal oxide layer comprises an active element that changes internally as a function of an applied voltage.

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38. The memory of claim 37, wherein said applied voltage to said active element results in a predetermined current-voltage profile.

39. The memory of claim 24, wherein when a voltage is applied to said memory, beyond a threshold voltage, charge is accumulated in the memory element, thereby shifting current-voltage and capacitance-voltage characteristics, and

wherein upon reversal of the applied voltage, beyond a second threshold voltage, the charge in the memory is discharged, thereby restoring original current-voltage and capacitance-voltage requirements.--